

AMENDMENTS TO THE SPECIFICATION

On page 1, after the title, please insert the following paragraph:

This application is a nationalization of PCT application PCT/JP2005/002200 filed on February 8, 2005, claiming priority based on Japanese Application No.2004-055005 filed on February 27, 2004, the contents of which are incorporated herein by reference in their entirety.

Please replace the paragraph beginning at page 8, line 1, with the following amended paragraph:

Figs. 1 and 2 7 and 8 each show an embodiment of a process for heating a film with free ends under a tension a production example of the inventive film.

Please replace the paragraph beginning at page 8, line 3, with the following amended paragraph:

Figs. 3 and 4 1 and 2 each show an exemplary hot-air furnace.

Please replace the paragraph beginning at page 8, line 4, with the following amended paragraph:

Figs. 5 and 6 3 and 4 each show an exemplary radiant heating furnace.

Please replace the paragraph beginning at page 8, line 6, with the following amended paragraph:

Figs. 7 and 8 5 and 6 each show an exemplary furnace capable of simultaneously applying hot air and radiant heat rays to a film.

Please replace the paragraph beginning at page 8, line 14, with the following amended paragraph:

Fig. 11 shows a specific experiment of applying heat and/or tension to a film with ends fixed after step (B) (referred to as end-fixed).

Preliminary Amendment
Attorney Docket No. 062935

Please add the following paragraph between lines 6 and 7 at page 15:

As described later the inventive film produced in step (B) is in a state before completion of imidization and solvent removal, while in step (C) the imidization proceeds to a sufficient degree and the produced film contains almost no residual solvent. In order to attain the states of the films obtained in step (B) and (C) as above, it is preferable to employ the heating condition in a manner that the temperature of the step (B) is 20°C or more lower than that of the step (C), which makes the final film oriented in Machine Direction (MD).

Please replace the paragraph beginning at page 16, line 7, with the following amended paragraph:

When hot-air heating is employed in step (C), the hot-air heating is ~~preferably~~ performed at 430°C 400°C or higher, ~~more~~ preferably 450°C 430°C to 570°C, most preferably 470°C to 560°C. At a maximum atmospheric temperature below 430°C, in some cases, the effect of orienting the film in the machine direction is not satisfactorily achieved; hence, a film oriented in the machine direction across the full width may not be obtained. When the heating with radiant heating rays is employed, the heating with radiant heating rays is preferably performed 400°C or higher, more preferably 430°C to 570°C, most preferably 450°C to 560°C. At a maximum atmospheric temperature below 400°C, in some cases, the effect of orienting the film in the machine direction is not satisfactorily achieved; hence, a film oriented in the machine direction across the full width may not be obtained.

Please replace the paragraph beginning at page 17, line 24, with the following amended paragraph:

The present inventors found that a film oriented in the machine direction can be produced by controlling heating conditions in steps (B) and (C). Unlike the baked polyimide film obtained by the process disclosed in Patent document 2 in which imidization and removal of solvent are completed, the inventive film produced in step (B) is in a state before completion of imidization and solvent removal. Therefore, it is difficult to completely express the state of the inventive film in terms of, for example, the degree of imidization and the content of a residual component. The present inventors found that the state before completion of imidization and solvent removal can be expressed by the thickness of the film. The present inventors also found that the heating conditions (temperature, tension, and residence time) in each step should be set so as to satisfy the relationship:

$$b > c$$

where b represents a thickness of the film obtained ~~in step (B) through step (C)~~, and c represents a thickness of the film obtained in step (C).

Please replace the paragraph beginning at page 23, line 5, with the following amended paragraph:

The polyimide film may be produced from the polyamic acid solution by a known process, such as thermal imidization or chemical imidization. The thermal imidization means a process for accelerating imidization by heating alone without a dehydrating agent and/or an imidization catalyst. Heating conditions can be changed depending on the type of polyamic acid, a film thickness, and the like. The chemical imidization means a process in which an organic solution containing polyamic acid is allowed to react in the presence of a dehydrating agent and an imidization catalyst. Examples of the dehydrating agent include aliphatic acid anhydrides such as acetic anhydride; and aromatic acid anhydrides such as benzoic anhydride. Examples of the

imidization catalyst include aliphatic tertiary amines such as triethylamine; aromatic tertiary amines such as dimethylaniline; and heterocyclic tertiary amines such as pyridine, picoline, and isoquinoline. Among these, in particular, acetic anhydride is particularly preferable as the dehydrator. Isoquinoline is particularly preferable as the imidization catalyst. To obtain an excellent polyimide film, 1.0 to 4.0, preferably 1.2 to 3.5, more preferably 1.5 to 2.5 moles of acetic anhydride is added per mole of amic acid in an organic solution containing polyamic acid. To obtain an excellent polyimide film, 0.1 to 2.0, preferably 0.2 to 1.5, more preferably 0.3 to 1.2, most preferably 0.3 to 1.1 moles of isoquinoline is added per mole of amic acid in an organic solution containing polyamic acid. For example, imidization in a short time after mixing polyamic acid, a dehydrator, and an imidization catalyst may cause poor fluidity in a die and breaking of the film while the film is transferring in a tenter furnace.

Please replace the paragraph beginning at page 27, line 21, with the following amended paragraph:

This polymeric solution was cooled to about 0°C. Then, 2.0 mol of acetic anhydride and 0.5 mol of isoquinoline were added per 1 mol of amic acid in the polyamic acid organic solution cooled at about 0°C. The mixture was adequately stirred. The mixture was cast and applied onto an endless belt by extruding through a die so that the film had a thickness of 25 μm after being dried and baked. The applied solution was heated at 85°C for about 4 minutes on the endless belt to produce a gel film, the content of volatile components of the gel film being 50 percent by weight. The resulting gel film was stripped. Subsequently, both ends of the film were fixed on a pin seat for continuously carrying the film. The film with both ends being fixed was carried into a hot-air furnace as shown in Fig. [[4]] 2 and heated at 300°C for 30 seconds. Subsequently, the film was carried into hot-air furnaces maintaining temperatures of 340°C and 370°C and heated for 30 seconds, respectively. Next, the film was heated at 350°C for 30 seconds with a far-infrared

heating furnace which uses far-infrared rays as a radiant heat source, as shown in Fig. [[5]] 3. When the film was carried from the far-infrared heating furnace to the exterior, the film was stripped from the pins and wound to obtain an end-fixed film (long film) having a thickness of 25 μm and a width of about 1 m.

Please replace the paragraph beginning at page 27, line 21, with the following amended paragraph:

This polymeric solution was cooled to about 0°C. Then, 2.0 mol of acetic anhydride and 0.5 mol of isoquinoline were added per 1 mol of amic acid in the polyamic acid organic solution cooled at about 0°C. The mixture was adequately stirred. The mixture was cast and applied onto an endless belt by extruding through a die so that the film had a thickness of 25 μm after being dried and baked. The applied solution was heated at 85°C for about 4 minutes on the endless belt to produce a gel film, the ~~content of volatile components~~ residual component ratio of the gel film being 50 percent by weight. The resulting gel film was stripped. Subsequently, both ends of the film were fixed on a pin seat for continuously carrying the film. The film with both ends being fixed was carried into a hot-air furnace as shown in Fig. 4 and heated at 300°C for 30 seconds. Subsequently, the film was carried into hot-air furnaces maintaining temperatures of 340°C and 370°C and heated for 30 seconds, respectively. Next, the film was heated at 350°C for 30 seconds with a far-infrared heating furnace which uses far-infrared rays as a radiant heat source, as shown in Fig. 5. When the film was carried from the far-infrared heating furnace to the exterior, the film was stripped from the pins and wound to obtain an end-fixed film (long film) having a thickness of 25 μm and a width of about 1 m.

Please replace the paragraph beginning at page 29, line 14, with the following amended paragraph:

This polymeric solution was cooled to about 0°C. Then, 2.1 mol of acetic anhydride and 1.1 mol of isoquinoline were added per 1 mol of amic acid in the polyamic acid organic solution cooled at about 0°C. The resulting mixture was adequately stirred. The mixture was cast and applied onto an endless belt by extruding through a die so that the film had a thickness of 25 μm after being dried and baked. The applied solution was heated at 85°C for about 4 minutes on the endless belt to produce a gel film, the ~~content of volatile components~~ residual component ratio of the gel film being 50 percent by weight. The resulting self-supporting gel film was stripped. Subsequently, both ends of the film were fixed on a pin seat for continuously carrying the film. The film with both ends being fixed was carried into a hot-air furnace as shown in Fig. [[4]] 2 and heated at 350°C for 60 seconds. Subsequently, the film was carried into hot-air furnaces maintaining temperatures of 400°C and 450°C and heated for 30 seconds, respectively. Next, the film was heated at 410°C for 30 seconds with a far-infrared heating furnace as shown in Fig. [[5]] 3. When the film was carried from the far-infrared heating furnace to the exterior, the film was stripped from the pins and wound to obtain an end-fixed film (long film) having a thickness of 18 μm and a width of about 1 m.

Please replace the paragraph beginning at page 30, line 13, with the following amended paragraph:

A film was produced as in Production example 2 of end-fixed film until the heating with the hot-air furnaces had been performed. Then, the film was heated at 520°C for 30 seconds with a far-infrared heating furnace as shown in Fig. [[5]] 3. When the film was carried from the far-infrared heating furnace to the exterior, the film was stripped from the pins and wound to obtain an end-fixed film (long film) having a thickness of 18 μm and a width of about 1 m.

Please replace the paragraph beginning at page 31, line 25, with the following amended paragraph:

The end-fixed film produced according to Production example 1 of an end-fixed film was carried into hot-air and far-infrared heating furnaces as shown in Fig. [[8]] 6 and heated and then wound while the tension was controlled by a roll-to-roll process as shown in Fig. 11, thus producing a free end film. The production conditions were described as follows: residence time in the furnace, 45 seconds; furnace temperature, 460°C; and tension 0.32 kg/mm². Thereafter, the molecular orientation angles of the film were determined as in Example 1. In addition, changes in thicknesses before and after the treatment for the film were measured. Table 2 shows the results.

Please replace the paragraph beginning at page 33, line 12, with the following amended paragraph:

The end-fixed film produced according to Production example 2 of an end-fixed film was carried into a hot-air furnace as shown in Fig. [[4]] 2 and heated and then wound while the tension was controlled by a roll-to-roll process as shown in Fig. 11, thus producing a free end film. The production conditions were described as follows: residence time in the furnace, 30 seconds; furnace temperature, 470°C; and tension 0.71 kg/mm². Thereafter, the molecular orientation angles were determined as in Example 1. In addition, changes in thicknesses before and after the treatment for the film were measured. Table 2 shows the results.

Please replace the paragraph beginning at page 33, line 25, with the following amended paragraph:

The end-fixed film produced according to Production example 2 of an end-fixed film was carried into a far-infrared heating furnace as shown in Fig. [[6]] 4 and heated and then wound while the tension was controlled by a roll-to-roll process as shown in Fig. 11, thus producing a free end film. The production conditions were described as follows: residence time in the furnace, 30 seconds; furnace temperature, 500°C; and tension 0.34 kg/mm². Thereafter, the molecular

orientation angles were determined as in Example 1. In addition, changes in thicknesses before and after the treatment for the film were measured. Table 2 shows the results.

Please replace the paragraph beginning at page 34, line 13, with the following amended paragraph:

The molecular orientation angles of a film were determined as in Example 2, except that the film was heated with the far-infrared heating furnace having a temperature of 430°C as shown in Fig. [[6]] 4. In addition, changes in thicknesses before and after the treatment for the film were measured. Table 2 shows the results.

Please replace the paragraph beginning at page 34, line 20, with the following amended paragraph:

The long, low-temperature baked film produced according to Production example 1 of an end-fixed film was carried into hot-air and far-infrared heating furnaces as shown in Fig. [[8]] 5 and heated and then wound while the tension was controlled by a roll-to-roll process as shown in Fig. 11, thus producing a free end film. The production conditions were described as follows: residence time in the furnace, 45 seconds; furnace temperature, 470°C; and tension 0.10 kg/mm². Thereafter, the molecular orientation angles of the film were determined as in Example 1. In addition, changes in thicknesses before and after the treatment for the film were measured. Table 2 shows the results.

Please replace Table 2, on page 38, with the following Table 2

Table 2

		Molecular orientation angle °	Measurements			Thickness after treatment μm	
			Initial thickness μm		(b) (c)		
			(b)	(c)			
EXAMPLE 1	0	0	1	0	-1	0	
EXAMPLE 2	-2	-1	-3	2	1	25.0	
EXAMPLE 3	5	0	-6	2	4	24.5	
EXAMPLE 4	-1	1	0	2	0	24.8	
EXAMPLE 5	-1	0	-2	-3	0	25.0	
EXAMPLE 6	-1	0	-1	-2	1	24.6	
EXAMPLE 7	1	-1	0	-2	0	24.6	
EXAMPLE 8	1	-1	-3	-3	1	24.3	
EXAMPLE 9	-9	-10	-8	-9	7	23.9	
EXAMPLE 10	-6	-5	-5	-6	0	24.4-17.6	
EXAMPLE 11	-15	7	-12	8	10	24.7 17.8	
COMPARATIVE EXAMPLE 1	-45	-25	8	19	88	24.6	
COMPARATIVE EXAMPLE 2	-47	-40	-22	0	31	-	
COMPARATIVE EXAMPLE 3	-50	-40	-55	-54	-70	-	
EXAMPLE 12	-25	-28	-25	-5	11	24.9	
					22	25.0	